

upon it, therefore, as a piece of good fortune that synthesis demands the creation of countless new methods of construction, separation, and recognition, and the study of hundreds of intermediate products before the proteids themselves can be reached. For these methods not only serve in the end to produce all the natural albumins, but bring to light many more which may eventually serve to explain the remarkable changes which certain proteids effect in the form of ferments and toxins.

J. B. C.

THE PROTECTION OF BIRDS.

IN its report for 1905, the Royal Society for the Protection of Birds directs attention to the circumstance that the year under review is the first during which it has enjoyed the privilege of a Royal Charter. Reference is also made to the importance of last year's ornithological congress in connection with the recognition of the great principle that bird-protection is an international affair, and that, in the case of migratory species, it is of little use to adopt protective measures in this country if indiscriminate slaughter is carried on abroad. It is, moreover, also pointed out that we are by no means free from reproach in this matter even at home, as is exemplified by the instance of a honey-buzzard which was killed and mounted in the Isle of Wight, although such procedure would have been illegal in Hampshire. The progress of bird-protection in India is referred to with approval; but it is stated that further international action is required in connection with the trade in "osprey-plumes."

Simultaneously with the report of the English Society for the Protection of Birds, we received those of the kindred American body, the National Association of Audubon Societies, for 1904 and 1905. The former of these contains a history of the "Audubon movement" in the United States by Mr. W. Datcher, the president of the association, and also the results of a special effort for the protection of water-birds, made possible by a fund at the disposal of the association. In the report for 1905 the president has to congratulate the association on its first year's working as a corporate organisation, the incorporation having largely augmented its power for good. After referring to the cordial relations existing between the association and foreign bodies the work of which is of a similar nature, the president directs special attention to correspondence relating to the urgent need of protection for the extensive bird-colonies in certain islands in the Pacific. Special efforts are being made to enlist the interest of the general public in bird-protection by means of exquisitely illustrated leaflets (of which we have received a sheaf) descriptive of some of the rare and more interesting birds. In the case of the cardinal and so-called American goldfinch, the illustrations are coloured.

THE PLACE OF POLYTECHNICS IN EDUCATION.¹

THOSE of you who know what you are doing here and know what is being done in other places must feel that we are at a very interesting, almost a critical, time from an educational point of view. We may be said, indeed, to be at the beginning of a new renaissance—a new birth of learning, just in the same way that our forbears, A.D. 1000 up to A.D. 1200, were in the forefront of that first renaissance. But the trouble is that the dark ages did not cease then, for we have had a dark age since, and it is to correct this second dark age that this new birth is necessary. Now what did the inhabitants of Europe do at that first renaissance? They kept on the schools which had been brought down by the different rulers, the different church authorities, from the time of the Roman Empire. The Roman schools, judging from what the Romans did from Scotland to the south end of the Red Sea, must have dealt with the science of the time, and that perhaps is the reason that the earliest universities always included "the nature of things" in their curricula. A modern public schoolmaster might not think their edu-

cation complete because Latin and Greek were the modern languages then, and the students were taught no dead ones; but, be this as it may, at the renaissance they insisted upon the teaching of Latin, because then everybody who was anybody spoke Latin—it was the *lingua franca* of Europe—and not to speak Latin was to belong to the corps of the deaf and dumb. Secondly, they had to learn Greek, because the movers in the educational world at that time were chiefly doctors, and they had learned all they could about doctoring and surgery from bad Latin translations of bad Arabic translations of the Greek authorities, so that when the Greek manuscripts became available all the world was agog to learn Greek in order chiefly that they might learn medicine and surgery. Now, I want to point out to you that in this we had education founded absolutely and completely upon the crying needs of the time. Very good. Then if we are going to do anything like that in our new renaissance, what ought we to do if we are to follow precedent? We must arrange our education in some way in relation to the crying needs of the time. The least little dip into the history of the old universities will prick the bubble of classical education as it is presented to us to-day. Latin was not learned because it had the most magnificent grammar of known languages. Greek was not learned in consequence of the transcendental sublimity of ancient Greek civilisation. Both these things were learned because people had to learn them to get their daily bread, either as theologians or doctors or lawyers, and while they learned them the "nature of things" was not forgotten.

Now what is the problem of to-day? We are in a world which has been entirely changed by the advent of modern science, modern nations, and modern industries, and it is therefore perfectly obvious that if we wish to do the best for our education it must be in some relation to those three great changes which have come on the world since the old days. Remember, in the old days there was no experimental philosophy, there was no steam, there was little relation practically between the ordinary lives of the people and the phenomena, or, at all events, the working of the world of nature around them. But with us all our life, the poorest life, the richest life, the country life, the town life, if it is to be lived properly and wholesomely, has to be lived in the full light of modern science; we have to know exactly the best thing to do and why we should do it. The problem before us to-day, if it be the same problem that was before those old peoples, the problem, that is to say, of learning everything we can from those around us in other nations, must drive us to the study of modern languages, just as the modern world conditions drive us to modern science, so that there, I think, we have an answer to those who may ask of us: What changes are you going to make in modern education if you are going to have the best possible education? First of all, we have the fact that we are bound, if we follow precedent, to deal with those things which are of importance from the present point of view. Latin is no longer the *lingua franca* of Europe, and we have better guides in science and philosophy than Aristotle. A question which arises when we go on to consider this matter is a very simple one: Is it worth while bothering about education? Is it worth while troubling to inquire what the old renaissance did or the new renaissance ought to do? Now there we approach a question in which the world is certainly very much wiser than it was a few years ago. Thirty or forty years ago, I am sorry to say, in this country practically nobody cared anything whatever about education, at all events about the education of the people, and the trouble with us now—the trouble that we shall have to take years to get over—is that in Germany that question was settled as early as the time of Luther, who insisted that it was the duty of all communities to look after the education of their children as well as the building of bridges and the making of roads. Now I think it is generally accepted, both in this country and in others, that whether the citizens of a State are educated or not is a matter of absolutely supreme importance, and when I say "educated" I mean educated morally and physically as well as intellectually. It is no longer merely the concern of the child or of the child's parent. It is acknowledged to be the only true foundation for a

¹ Extracts from an Address delivered at the Borough Polytechnic Institute on December 4, 1905, by Sir Norman Lockyer, K.C.B., F.R.S.

State's welfare and continued progress under conditions of peace or under conditions of war. We must face the applications of all the new sciences to every department of our much more complex national life, from the lowest employment to the highest fields of statecraft. If this is anything like true we have a great responsibility cast upon us when we talk about education. And when we inquire into the conditions we are still more impressed by this strenuous necessity of looking the facts in the face and seeing how this question affects us, not merely as being in this Borough Polytechnic, but as being Britons, as being members of a civilised community in the twentieth century. I have already said that even so far back as the time of Luther the Germans insisted that all their children should be educated; there should be no difference between the rich and the poor. What has grown out of that? The thing has gone on from strength to strength, until now in Germany, to deal with the Old World, we find a country with the greatest number of universities, with the greatest possible desire, from the Kaiser down to the peasant, to do everything for Germany that can be done by educating every child that is born in the country. What did democracy do when it had fair play in the United States of America? The first thing done was to apportion millions of acres for the future endowment of education. The acres did not mean much capitalised then, but they mean a great deal capitalised now; so that in the western States of America, where you get the purest voiced democracy that you can get, I think, on the surface of the planet, the children of the citizens, boys and girls, are educated from the age of six to the age of six-and-twenty without any call upon the parents or without any hesitation to carry as many as possible up to the very highest form of education. And when does the technical instruction come in there? The technical instruction is given only to those who have taken degrees in the university. Japan is following on the same lines. The educational system of Japan was started as near as may be at the same time that the new educational policy was begun here. The result of it has been that you have in Japan now a completely trained nation, trained to think, trained to do the best along any line that may turn up, and the difference between the existence of such a training and its opposite we have now in comparing the present condition of Japan with the present condition of China. Japan has become a world Power with whom we are proud to associate simply because the Japanese children have been taught to think and to do for thirty years. That is one of the most blessed things to think of, because it shows that if any nation, even the British nation, ultimately finds that it is backward, some thirty years, or perhaps even twenty years, spent in Japanese fashion may put everything right. But if that is so, then it is my duty to point out to you that we have a great deal to do. I have said that our present system of education was commenced, roughly, some thirty years ago, when the Japanese system was started, but at present our system deals only with primary and secondary education. It is a most extraordinary thing that our Minister of Education has not anything to do with the most important part of education. It is a situation truly British. Well, if we find that it is necessary to imitate the action of other States in having a department which shall include the top of education as well as the bottom, it is right that I should tell you at once that this will cost a great deal of money above what we spend at present. If we take one German university, Berlin—the equivalent of the University of London—the German State spends on it the sum of 169,000*l.* a year. That is to say, it spent that sum in the year 1891-2; whereas for our higher educational institutions—all the universities and university colleges in England, Ireland, Scotland, and Wales—until quite recently, the British Government allowed a smaller sum. That, I suppose, perhaps may be considered a fair estimate of the importance of education in the eyes of the British Government and in the eyes of the German Government. The worst of all this is that it is not merely a question of money and increasing taxation; it is a question of the hampering of all the industries of the country from top to bottom, from John O'Groats to Land's End. In an official document published by the United States Government some four years ago, it was stated, as a result of

considerable inquiry, that, taking the day students in the United States, in those colleges and universities where only day students were considered, there were more teachers of science in the United States than there were students of science turned out from the English colleges. Now, if that or anything like it is true, do you think that in any continued competition along any line in connection with any industry in the United States and here, we are likely to come out top? It is absolutely impossible. Sir William Mather, more recently, has given us some information on this point. He spent four months in America looking up the technical colleges and the conditions relating to the education of the industrial classes. He found that ten years ago there were attending educational establishments, that is to say, universities and colleges, 32,000 day students; all these were taking a three years' course. To-day there are 65,000 students being educated at these same colleges, and he says the spirit of America is so completely aroused to the necessity of making science the basis of all industry, it does not matter whichever it is, however simple the undertaking, that the whole tendency and trend of thought and feeling is to educate large masses of their young men so that they may take their part, not only as managers, employers, and capitalists, but as foremen and chief workmen in their great industries; and he ends by saying that it is necessary that we should urge our Government, whether it be Liberal or Conservative, to take care that there should be sufficient expenditure provided to enable our young people throughout the length and breadth of the land to possess equal advantages to those of young people of Germany and America.

If it is right that there should be this education, conferring upon the nation these enormous advantages, in considering the thing from the point of view either of the child or the child's parent, should there be one State-aided education for the rich and another for the poor? That is to say, if education—the best education—is worth all that is claimed for it, should the State deliberately foster the artificial production of a breed of second-rates? How can every child have a fair chance? Some of the older ones among you may remember Kingsley's "Saint's Tragedy." I will just quote two verses, with a little alteration in one:—

"The same piece of clay makes a tile,
A pitcher, a taw, or a brick;
Dan Horace knew life—you may cut out a saint
Or a bENCH from the self-same stick."

"We fall on our legs in this world,
Blind kittens tossed in neck and heels;
'Tis education that licks Nature's cubs into shape,
She's the mill-head if we are the wheels."

Surely, then, if we must not differentiate education, if we must not knowingly support second-rate education, our duty is to find the best. We come, then, to the problem which I have not the courage to bring before you now, because one might talk for a week about it, and I have only twenty minutes left, even if you will grant me as much as that.

What is the best education? It has taken the world a long time to find out what it already knows about it, but I doubt whether even now the world has quite got to the bottom of the problem. I think we may begin by saying that the best education should teach us to learn how to think, how to observe and how to use our hands, eyes and brain; how to exercise the body, how to become good and useful citizens, and—this is my own notion, perhaps you all will not agree with it—how to bear arms. If you have such an education as that going on all over the United Kingdom, my idea is that, whatever may happen to them afterwards, whether the children become archbishops or ploughmen, they would not be harmed by such an education, and, as a matter of fact, they could not have spent their time better. Now that is a very important thing to bear in mind, because there are systems of so-called education about which it could be shown in a moment that those who have been put under them might have spent their time very much better. We must discriminate really very much more carefully than is generally done between education, which I will define as the power of learning how to think, and instruction, which means

the accumulation of facts. Education may bring us into contact with doing things by which money may be earned, but that contact in education is used for mental training. Useful knowledge may easily become the bane of education. Instruction in doing things frankly pursued for the purpose of earning a living is generally not so imparted that the power of thinking properly is increased and the general training carried on further. If that is anything like true, we come to the important consideration that the best teaching must certainly include the teaching of doing things—we must not merely cultivate the memory—and, above all, we must not stuff useful knowledge or anything else into those young minds with which we have to deal. They are not Strassburg geese; and the more you attempt to stuff them the worse it will be. What we have to do is to train the mind as a delicate rapier, enabling it to do anything it has to do in the most perfect manner—to train the eye, the hands, the brain to face anything under the best possible conditions. The question here arises, What sort of a Code have we now for the education of the young?—this new Code—the Code for the year 1905 for elementary schools. Well, for myself, I thank God that we have such a document. It is an enormous improvement upon everything, upon anything, which has gone before it in our country. I remember some twenty years ago, when the only concession made to the new knowledge was that some candidate, if he liked, might say something of what he knew about the common pump; it hardly went further than the common pump, but the new Code goes very much further than the common pump, and you may even look at the stars if you like; you may even observe once or twice a year where the sun is or where the moon rises. Having this official education for the young, how are we to deal with it in relation to such an institution as yours? How are we to consider what should happen to the young minds of boys and girls going up that educational ladder which Huxley pictured to us some years ago—that educational ladder from the gutter to the university? In considering such a ladder as this, of course the end of the teaching, the end of the time spent, in the primary school constitutes the first rung at which the educational ladder may be left, and you have to consider the certain number of boys and girls unfortunately getting off the educational ladder when they leave the elementary school. The question arises, Must everybody when they leave the primary school, and that, I am thankful to say, at a gradually increasing age; when they have done with the official, with the complete education, must they have done with the instruction which will enable them better to earn their daily bread—the instruction which should, if possible, be placed before them, because really it is to tackle that instruction and to tackle the life connected with it that they have been taught to think? If you omit to give a higher education, or education combined with instruction, to your boys and girls after you have taught them to think, you have made a good deal of that education ridiculous. Your institute proves that it is much better to give instruction to the young in things that they have to do before you make them absolutely face the music in the real contact with the stern world of reality, which they will certainly have to face sooner or later. When you consider, therefore, the stepping-off places from the education ladder—I have just referred to the first—and the necessity of getting instruction, of putting instruction in the way of those who have to step off the educational ladder, the importance, the enormous importance, of such an institution as yours begins to force itself upon one. Take the child in an elementary school under the present regulations. Instead of going on to the secondary school and continuing still further up the educational ladder, it can go to a higher elementary school. That is a new idea in England, and it is a very admirable one. When you ask, Why does the child step off? you will find yourself confronted chiefly with the dearness of education in this country, and then with the supposed necessity for early employment.

With regard to those two questions, I would just like to tell you a little story. I had, some thirty years ago, to visit Holland on an official mission, and among others I saw the Minister of Public Instruction there, who was

a great friend of Prof. Reike, to whom I was accredited, and he told me what they had been doing then in Holland for the last six or seven years; precisely this same thing that the Board of Education is now doing with regard to the higher elementary schools. The boys left the elementary schools generally at the age of fourteen, and the habit was for those little creatures to be sent at once to the offices and counting-houses of the merchants in Rotterdam and Amsterdam and other places to begin their work as clerks, and the Minister told me, with a twinkle in his eye, that these shops and counting-houses were most extraordinary places, because they were full of high stools. The Minister thought he could not proceed with this suggested change of the continuation school, which was called the higher town school, until he could get the sympathy of those various merchants, and he went round and asked them whether, if he could prepare boys up to the age of seventeen years, they would make a trial of them. They said they would. I visited Holland some four or five years after this had taken place, and the Minister told me that if I went to Rotterdam or Amsterdam I should no longer find any of those tall stools. He said:—"Seventeen-year-old boys are there, and they will have none others; the time for the use of the boy of fourteen in a merchant's office in Holland has passed away; the boys who begin to do their work after they have been taught to think up to seventeen are so much better." There is just another story touching another point I will say a word about later. The Minister was so interested with this, and was so satisfied and delighted at the satisfaction which those boys gave to their employers, that he thought he would go a step further. I should tell you that the boys who continued in school after fourteen up to the age of seventeen were chiefly taught science and Latin, and he was anxious to know what would happen in the case of a competition between these boys and those from the gymnasias, which are the equivalents of our higher grammar or public schools in this country. The boys from the gymnasias went, in the natural course, when they left the gymnasias, to the university. So he obtained permission from the Government to give the high town school boys an extra year. Now, what did they have to do in this extra year? They had learned Latin, and they had learned science from the age of fourteen in their continuation school; all they had to do was to learn Greek. It seemed an impossible thing for the town schoolboys to attempt to learn as much Greek in nine months, which was the school year, as the boys in the gymnasias, who had been accumulating during nine years their instruction in the gymnasias and the primary schools; but, as a matter of fact, when the test leaving examination came to be gone through, the boys from the higher town school romped in over the gymnasias boys. So you see my story shows that the university is not an absolutely prohibited thing if those who have to do with the boys and girls concerned are keen enough to take every advantage of every opportunity; and it shows also that employers of labour, at all events in other countries, and I expect in this, will see the advantage of getting supplied with clerks and other assistants who have been taught to think as opposed to getting their offices crowded with people who have still to learn how to think.

There are several other questions connected with the Huxley educational ladder. One is that in leaving each rung we have frankly to acknowledge that we have to face the music of the struggle for existence. Not every boy who enters a primary school can go, of course, to the university, can go perhaps higher than a secondary school; some will even fail to get to a secondary school, but what you have to consider, I think, generally in relation to institutions like this is that if there is to be any stepping off the ladder the change must be made in the best possible way. The present system of allowing these changes from rung to rung to take place by examination by outsiders is, I think, absolutely and completely indefensible. I would hold the teachers in every primary school absolutely responsible for saying that such and such of their students will benefit by secondary education and some of their students will not, and if that be done, then, in consequence of the recent action of the London County Council,

it seems to me that you will have a rapidly increasing number of the best English boys and girls going on with their pure education, certainly well into the secondary stage. In this way you will catch your potential Faradays. One of the delightful things I found in my inspection here with Mr. Millis was that in your instruction, frankly so called, you make it as educational as you can, so that those who come to you after the age of the primary school may, if they so choose, by taking advantage of one or other of your organisations, not only get an immense amount of absolutely needed instruction for various walks of life, but an education which will be practically as good as an education which could be got on the ordinary education ladder to enable them to enter the universities. The recent improvements in education are brought home to us by the fact that Huxley's ladder by itself no longer represents all the present possibilities. There are now platforms at the chief stepping-off places, and ladders from them also leading to the university for those who do not fear to climb. These platforms are technical schools and institutes, in which practical training in science laboratories and literature must both find place.

There is one word I should like to say with regard to your day school. It is called a "Technical Day School for Boys." I find that in the London County Council list, Appendix B, it is called a "secondary school." Now are you a secondary school? That is a point that I am not quite familiar with. What I understand is that under the new regulations a school to be a secondary school must make application to the Board of Education to be reckoned as such, and if it is accepted you have this enormous advantage, or will have very shortly, if you have not it now. Your students will have the right to go to the university by passing the leaving examination, which will ultimately be carried on by the teachers in the secondary school, or, at all events, with teachers associated with the secondary school. I think you will agree with me that the less any education in any locality is fettered by examination by outsiders the better for that education it will be. If you are a secondary school your students will be able, as a matter of course, to enter the new university. Thank God that in London, after centuries of the neglect of education, we have a university; we shall soon be as well off as a good many second-rate towns on the other side of the water have been for hundreds of years. I believe it is settled that your students can matriculate at the university, can become internal students without the bugbear of Latin, if you look upon Latin as a bugbear. Personally, I do not; if you have time to learn Latin, so much the better; but if the struggle for existence is so great that it is science or nothing with you, well, with science you can now enter the London University from a secondary school. You will then carry your local students right up to the second rung, some will go on to the university, and some will step off to your evening classes. Voltaire, talking about education, said:—"On étudie les livres en attendant qu'on étudie les hommes" ("We study books before we have a chance of studying men"). Well, we have got past that now; we not only study books, but we study things, but whether we study books or things our education will not be complete until we study men, that is to say, until we have varied occasions of mingling with others who are thinking about other things, so that we may exchange thoughts and ideas and sympathies with other students of different branches of knowledge. Now I want to point out what a magnificent opportunity you have here for that kind of collegiate education. You are practically a college, and I believe strongly that this collegiate life, as we may call it, this mixing with one's fellow men, is of the very highest quality, that it is the absolute essential of a complete course of education which should produce what is called character. And let me remind you that people are prepared to pay a great deal for character. I find, for instance, that Mr. Balfour not very long ago said the collective effect of our public school education on character could not be over-rated, but he thought the boys of seventeen or eighteen who are educated in them do not care a farthing about the world they live in except so far as it concerned the cricket field, the football field, or the river. You have the machinery to enable you to care a

great deal about the world you live in, to know an immense deal about it, and you have also the machinery for this formation of character. Now I believe in the combination, and it is upon that ground I hope some future day to see a strong secondary school here. I believe it will be a very great boon to this part of London; in fact, I feel so strongly on this that I should say your enormous advantages would be wasted if you did not take some part in the general scheme of pure education, and that part is quite obvious; you have to make your day school one of the best secondary schools it is possible to imagine. I should have hesitated to give you my opinion on your proper place in education and the excellence of your teaching staff and laboratories if I had not had an opportunity of examining your institution, and, in concluding, I want again to thank Mr. Millis for his very great kindness in showing me over it the other day.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. R. S. LULL, associate professor of zoology at the Massachusetts Agricultural College, has been appointed assistant professor of vertebrate palaeontology in Yale University, and associate curator of vertebrate palaeontology in the Yale University (Peabody) Museum.

PROF. W. W. WATTS, F.R.S., who is leaving Birmingham to take up the professorship of geology at the Royal College of Science, was entertained by his geological friends in Birmingham on March 23. Prof. Charles Lapworth, F.R.S., who presided, referred to the many services which Prof. Watts had rendered to geological students. Prof. Watts, after acknowledging the presentation made by Mr. J. Whitehouse on behalf of the past and present students, said that he was going to a school which would be in healthy but friendly rivalry to the Birmingham school.

AMERICAN institutions for providing higher education continue to benefit from the generosity of wealthy American citizens. *Science* announces that Princeton University has been made the residuary legatee of the estate of Mrs. J. Thompson Swan, which is said to be worth about 60,000*l.* The late Mr. Edwin Gilbert, of Georgetown, Conn., has left 12,000*l.* for the model farm of the Connecticut Agricultural College. Harvard University has received a gift of 10,000*l.* from Mr. R. W. Sayles, of Norwich, Conn., to establish a fund, preferably for the acquisition, preparation, and maintenance of collections suitable for a geological museum.

THE Board of Education has issued a return showing the extent to which, and the manner in which, local authorities in England and Wales have applied funds to the purposes of technical education, and other forms of education other than elementary, during the year 1903-4. In consequence of the fact that the Education Act, 1902, was coming into operation throughout the year with which the report deals, and that advantage was taken of this fact to initiate a new series of returns of this form of expenditure, the year must be regarded from the statistical point of view as transitional in character. The volume is, in fact, divided into two parts, the first continuing for about half the total number of local authorities the former series of returns, and the second initiating the new series for the remainder. The consequence is that the volume provides no total of the figures dealing with the whole country, and in view of the incompatibility of the bases of the expenditure shown in the two parts, such totals would only be misleading.

THE 1906 issue of the "Register and Official Announcement" of the Clark University, Worcester, Massachusetts, has been received. Among other interesting information, it may be noticed that the University has several funds for the endowment of fellowships. A sum of 600*l.* is now available for junior and senior fellowships from the George F. Hoar fund of 20,000*l.*, provided by the generosity of Mr. Carnegie. There are in addition a citizen's fund of 1000*l.*, the income of which is to be used for the aid of "some one or more worthy native-born citizens of the city of Worcester